



STRUCTURAL DESIGN CRITERIA FOR MUSEUMS

FLOOR LOADING

The most obvious and first thought that comes to mind when you think of criteria for structural engineering is the loading requirements of the space. In a museum this deserves a much more in-depth review than simply applying the provisions of the code. We generate a question list at an early stage in schematic design to begin to identify where special loading requirements will be required.

For example:

Gallery Space: The code states that areas of public occupancy shall be designed to support 100 pounds per square foot superimposed live load without taking advantage of the code-provided reduction formulas. This should be and is usually adequate, but in a general way. A heavy sculpture and the forklift required to transport the sculpture can create concentrated wheel loads on a small area considerably larger than 100 psf. So, in addition to the overall 100 psf design criteria, a concentrated load criteria must be established and thin slabs and short span structural elements need to be checked for this criteria. The museum might also need to take the floor loading criteria into consideration when they select equipment to drive across the floor to move sculptures and to change light bulbs. This should be discussed in the early design stages and design the structure to be compatible with equipment required to properly operate the facility.

In addition, some sculptures or other objects may need to be displayed by being hung from the ceiling. The code-minimum live load of 20 pounds per square foot will not be adequate for this, so the topic of hanging loads in the gallery spaces must be addressed during design.

Storage Vaults: The building code establishes live loading for storage areas in the 125 psf to 150 psf range. But, to conserve space, many museums are utilizing compact files which can produce live loading in the area of 300 psf and above. It is extremely important to identify the need for, and the location of, compact files (maybe even if for future expansion) in order to have the strength designed into the structure.

Some museums are using hanging racks to store art. Although the floor of the vault area may be designed for 125 psf live load or greater, all of the storage load on a hanging rack is going to the ceiling. Therefore the floor of the space above has to be designed to support the live load intended for that floor and also has to be designed to support the hanging load from below. Although it might be unusual to hang a 100 psf load from a hanging rack, the rack manufacturer designs these systems to support this load. So, in effect, the floor above, if it is a gallery for example, would have to be designed for 100 psf public occupancy live load plus 100 psf hanging load from below or a total of 200 psf.

CLEAN AIR

One problem for museum quality art can be particles of spray fireproofing on a steel structure circulating in the air conditioning system. Steel construction, particularly for roof construction, may be a practical solution if fireproofing is not required. If fireproofing is required and steel construction still appears to be the desired economical choice, then a troweled-on cementitious fireproofing may be worth considering. The design team should receive guidance from the museum on this issue.



WATER DAMAGE

Depending on the organization of the spaces and the location of water lines in the building, it may be necessary to recess the structure over storage vault areas and add a waterproof membrane and topping to protect artwork. Obviously the desired solution is to avoid this condition, but if required this solution can be implemented.

VIBRATION SEPARATION

Depending on the proximity of the mechanical room to the theatre and the type of usage of the auditorium, there may be a requirement for a structural separation to prevent transmission of vibrations through the structure. This can impact structural framing systems and should be addressed during the early planning phases.

COLD STORAGE

Cold storage areas require recessing and strengthening the floor for insulation and a topping slab. Above the cold storage unit, the design team must consider how to support the insulated ceiling.

CURATORIAL & BACKSTAGE SPACES

These areas often have concrete block walls instead of drywall. This adds considerable loading to the structure in the area where the walls occur. We need to account for this weight, if it occurs, in our calculations, and provide extra framing stiffness to prevent cracking the walls.

SLAB-ON-GRADE CONSTRUCTION

Slab-on-grade construction is economical, but we often recommend that this be considered as a value engineering option to bring the project back in budget, if necessary, while recognizing the risks. The risk of some slab movement and associated damage to partitions, doors, etc. is normally identified in the soil report. This risk can be minimized with the recommended soil preparation, but it still exists.

A major potential problem with slab-on-grade construction in a museum is the difficulty of repairing broken water lines that occur below the slab. Putting the lines in the ceiling above the floor to avoid this possible problem can create an even worse problem.

Also, since museums tend to have long useful lives, they are often renovated over time. A suspended ground floor over a crawlspace allows for the utilities and MEP infrastructure to be rerouted without tearing up the slab. This can be critical to keeping portions of the museum operational during renovation work.

If a slab-on-grade is used, a specialty consultant should address the possible increased humidity in the building due to potential vapor transmission and if it is at a level that could be a concern.



STRUCTURED GROUND FLOOR

A structural ground floor with a crawl space is often a good choice for long term performance and underfloor flexibility for repairing broken lines or relocating lines, if the following steps are taken:

- Construct the bottom of the crawl space above outside grade or create proper provisions to drain the crawl space in case it gets wet.
- Construct a vapor barrier and mud slab in the crawl space.
- Provide cross ventilation, perhaps providing forced ventilation or air-conditioning the crawlspace.
- Add insulation to the underside of the floor.
- Seal all penetrations in the floor around ducts and pipes.

Use of slab on void boxes is not recommended, due to the inability to access and repair broken water lines below the slab.

The slab-on-grade versus structured floor over crawlspace is an important quality decision that will require serious discussion during schematic design.

COLUMNS IN WALLS

Columns are typically larger than the thickness of interior walls and most exterior walls. This creates pilasters on the wall that project out on both sides or one side of the wall. In most exhibit spaces, a column projection into the space is very objectionable. It limits display space flexibility on the walls. Early in the design process we discuss with the architect:

- How to locate columns to miss display walls.
- When column is in display wall would it be possible to project the column to the other side of the wall leaving a smooth face on the exhibit side?
- Should you make the column a little smaller and the wall a little thicker to encase the column totally in the wall? It takes up a little extra space but may make the remaining space more usable.
- Look for ways to create this structural relationship to the functional use of the facility.

FUTURE EXPANSION

Historically, museums tend to grow over time, often beyond the scope envisioned at the time of the current design. It may be appropriate for planning purposes to design the structure and to at least consider the details that would make future expansion possible.

In addition to expansion by new construction, expansion is often accomplished by expanding compact storage areas and other heavily loaded storage. Some effort needs to be made to identify the possible locations of these potential expansion areas for the future.

Hopefully there will be enough information about future expansion plans to be able to design the structure to support future expansions, without having to construct new foundations up against Phase I when Phase II is built. Future foundation construction directly adjacent to the existing structure can be a vibration issue, and must be addressed.

A balance needs to be struck so that the additional dollars spent to provide future flexibility are used judiciously without running up the cost over large areas.